EV5 10/564415

IAP20 Rec'd PCT/PTO 09 JAN 2006

Fire-stop device which is used to protect walls or structures or to produce a protective chamber

The present invention relates to a fire-stop device for protecting walls or structures, or for producing a protective chamber.

This fire-stop device is ideal for protecting partitions, for example walls of buildings requiring particular thermal protection, or for protecting the arches of road or rail tunnels. This device may also be used for protecting metal beams used in particular in the building trade. This device may also be used for producing channels forming cable trays, or cabins for protecting people or equipment.

The materials used in the building trade have different thermal insulation properties, that are generally measured using the heat transfer coefficient λ. Thus, concrete has a coefficient λ of 1.4 watts.$m^{-1\circ}.C^{-1}$. Cement grout has a coefficient λ of 1.2, plaster a coefficient λ of 0.40 and wood a coefficient λ of 0.35. Polystyrene has a coefficient λ of 0.05. However, like other conventional insulants, polystyrene is unstable above 200°C and releases toxic vapors when it burns. Plaster has an advantageous insulation coefficient. Moreover, it has poor moisture resistance and, when exposed to fire, it discharges the water that it contains, retarding the fire by vaporization. However, once the water has evaporated, a partition made from plaster or the plaster coating of a partition no longer has any mechanical strength.

Fire-stop devices are also available comprising an insulating coating, covering the structure to be protected, itself covered with a surface coating which, under the action of a temperature rise, forms an intumescent material, improving the thermal insulation.

Such a fire-stop device limits the conduction of heat between the side of the structure subjected to a temperature rise, for example due to a fire, and the other side of the structure. However, in such a case, only the heat transfer is delayed, this transfer, although limited by the fire-stop device, nevertheless occurring fairly rapidly.

Document FR 2 813 882 relates to a fire-stop device for protecting walls or structures comprising a coating based on cement, chalk, silica, hollow insulating materials and at least one wet-strength agent, and also a surface hardener consisting of a transparent aqueous solution of mineral salts in basic medium.

The protection procured by this device is only effective against heat conduction, by delaying the heating of the structure to which it is applied. However, the temperature progressively rises, ultimately destroying the protective device and leaving the structure unprotected.

The technical problem underlying the invention is the production of a fire-stop device which, in the absence of fire or temperature rise, resists moisture and corrosion due to various chemical agents, withstands a rapid temperature rise and stabilizes the surface temperature of the wall or structure to be protected, during a temperature rise on the side with the device.

For example, the device must be able to withstand a rapid temperature rise, for example a temperature rise of between 1200 and 1400°C, in three minutes, as may occur in the case of a hydrocarbon fire.

For this purpose, the fire-stop device concerned comprises an insulating composition suitable for covering the structure to be protected or for surrounding a protective chamber covered by a surface coating comprising

a mixture of potassium and lithium silicates and fine aluminum particles.

When the temperature rises to about 1000°C, the surface coating is unchanged. Because of the aluminum particles that it contains, it behaves like a mirror and reflects about 50% of the heat received by radiation. It should be observed that, in this temperature range, the radiation is mainly in the infrared region. Thus the thermal shock is damped, thereby elininating the risk of the composition, to which the surface coating is applied, bursting.

If the temperature rises above 1000°C, the coating is chemically converted with the formation of alumina and aluminum silicate, the coating having a surface texture similar to a vitrified surface and preserving its original reflecting properties, reflecting about 60% of the heat flux in a temperature range of 1200 to 1300°C, with radiation approaching the visible.

The combination of the reflecting effect of the surface coating, without its destruction during a temperature rise, and a layer of insulating composition of suitable thickness serves to reach an equilibrium temperature on the side of the structure or equipment to be protected. Hence the protection is guaranteed without any time limit. The thickness of the composition must therefore be adjusted according to the desired equilibrium temperature, which varies according to the type of structure concerned: concrete, steel or equipment to be protected.

The device according to the invention protects a structure from a temperature rise by limiting the transfer of heat by radiation, convection and conduction.

According to one feature of the invention, the

aluminum particles have the shape of lamellae. This shape is advantageous to ensure continuous coverage of the coating, like scales.

The aluminum lamellae have a thickness of about 0.2 µm and an average size (length and width) of between 10 and 15 µm, and preferably 13 µm.

The aluminum of the particles is stabilized aluminum, in order to withstand basic pH.

Advantageously, the surface coating comprises about 15 to 20% by weight of aluminum particles relative to the weight of potassium silicate.

According to another feature of the invention, the surface coating comprises a suspending agent for ensuring the stability of the solution while it is being sprayed onto the insulating composition. This suspending agent is used to stabilize the solution because, in its absence, the aluminum particles would rapidly settle.

According to another feature of the invention, the coating layer thickness is 1 mm or less.

It should be observed that it is unnecessary for the coating layer to be thick, the important factor being that it must adhere perfectly to the insulating composition, must remain stable at high temperatures ranging between 1000 and 1500°C, and must act as a mirror to reflect a large part of the heat flux.

According to a first possibility, the coating layer is applied to an insulating composition that comprises the following elements: gray cement, chalk, silica, hollow insulating materials, and wet-strength agent.

According to a further possibility, the insulating

composition comprises a hydraulic binder comprising the following elements: aluminosulfate clinker, crushed gypsum, lithium carbonate, borax or trisodium citrate.

Advantageously, the hydraulic binder has the following composition:

- aluminosulfate clinker: 75%
- crushed gypsum: 25%
- lithium carbonate: 0.5 to 1‰
- borax or trisodium citrate: 2 to 5‰

This hydraulic binder can be used in combination with gray cement or can replace all or part thereof.

Thus, in a first case, the insulating composition comprises, on the one hand, a substantially equal parts mixture of gray cement and hydraulic binder comprising the following elements: aluminosulfate clinker, crushed gypsum, lithium carbonate, borax or trisodium citrate and, on the other, the following elements: chalk, silica, hollow insulating materials and wet-strength agent.

In a second case, the insulating composition comprises the following elements: aluminosulfate clinker, crushed gypsum, lithium carbonate, borax or trisodium citrate, chalk, silica, hollow insulating materials and wet-strength agent.

The use of the abovementioned hydraulic binder, instead of about 50% of gray cement, when used as a coating, serves to benefit from an application time of one hour, complete hardening after about two hours, without cracking because the shrinkage is very low. Moreover, this binder improves the water retention, thereby enhancing the fire resistance of the composition.

This coating contains at least one flow and adhesion promoter, which may consist of cellulose ether.

Gray cement acts as a hydraulic binder and has good wet strength.

Chalk is a decarboxylation agent, allowing the formation of CO_2 during a temperature rise.

Silica ensures the hardness of the insulating composition and its high-temperature strength.

Advantageously, the insulating composition contains hollow insulating materials consisting of a mixture of glass microspheres (noblite) about 50 to 60 µm in diameter and expanded fired silica spheres (perlite) about 500 to 600 µm in diameter. These hollow insulating materials make the product lighter and enable it to retain air. These materials are suitable as fillers for the product without the use of fibers, thereby favoring the coating smoothing conditions.

According to a further feature of the invention, the insulating composition contains an element that improves its intrinsic strength and its wet-strength, consisting of a siliconate fixed to a porous filler, such as silica.

According to one embodiment, the coating has the following weight composition per 988 parts:

- gray cement and/or hydraulic binder	450
- chalk	50
- silica	350
- hollow materials	80
- expanded fired silica	30
- siliconate	25
- cellulose ether	3

If the composition is used as a coating, it is in the form of a powder having a bulk density of 0.7 $kg.l^{-1}$. This powder is mixed with water to obtain a density of 1.1

$kg.l^{-1}$. The pH of the slurry is about 13.

The intrinsic tear strength of the dry coating is about 5 bar.

After having been mixed, the coating is applied to the support to be protected. Depending on the type of support or structure to be protected, the thickness of the insulating coating layer varies and may be about 1.5 cm for a steel structure and up to 5 cm for a concrete structure like a tunnel arch. After the coating has dried, the coating layer comprising a mixture of potassium silicate and fine aluminum particles is sprayed onto the coating.

According to another embodiment, this device is formed from elements molded using the insulating composition made with the abovementioned hydraulic binder, without gray cement.

Advantageously, the molded elements consist of sections of chutes and sections of lids of which the ends have complementary interlocking profiles for producing a continuous channel with a constant wall thickness.

The invention is described below with reference to the schematic drawing appended hereto in which:

Figure 1 shows the temperature change curves;

Figure 2 is a perspective view of a channel;

Figure 3 is an exploded perspective view of several pieces of this channel; and

Figure 4 is a cross section of this channel, along the line IV-IV of Figure 2.

Figure 1 shows five curves indicating the temperature change as a function of time on the side of the structure to be protected, in the case of five protective devices of which the coating thicknesses range from 1 to 5 cm, the curves being considered from the top downward.

The coating used is the one described above.

The heating temperature is between 1000 and 1100°C, with a rise conforming to the "safe hydrocarbon fire" rule, except in the case of the bottom curve (dotted line), for which the heating temperature rises up to 1380°C.

It is interesting to observe that the temperature is stabilized in every case. The composite line at 250°C in the graph corresponds to the uppermost maximum temperature of a concrete structure.

It clearly appears from these curves that the desired equilibrium temperature can be adjusted by adjusting the thickness of the coating layer.

Figures 2 to 4 show a channel made from prefabricated elements obtained by molding the insulating composition in which the hydraulic binder contains no gray cement. Insofar as this is a cement-free composition, setting is very rapid and stripping can be achieved in a few minutes, about twenty to thirty minutes, without the need for heating. Such channels can be ideal for protecting cables, particularly electrical, telephone and safety lighting cables from fire, in exposed places such as tunnels.

As shown in Figures 2 to 4, a channel 2 is made from chute sections 3 and lid sections 4. Each chute section comprises, at one of its ends, and substantially over half of its thickness, a tenon-shaped part 5, suitable for penetrating into a complementary recess 6 arranged in the end of the adjacent chute section. Similarly, the lid sections 4 have a central part 7 that fits into the chute, the central part having a thickness equal to the thickness of the chute walls, in order to maintain a constant material thickness along the whole periphery of the channel. It should be observed that the ends of the lid sections also have breaks 8 in the thickness direction, for jointing the ends of two lid sections, to obtain a constant lid thickness.

The molded elements may also consist of tiles, whose edges have breaks for assembly with neighboring tiles, these tiles being useful for constructing the volume of protection intended, for example for individuals, in tunnels, or for equipment to be protected against a temperature rise, particularly in the case of fire.

The adhesive used to assemble the prefabricated elements may consist of the binder itself containing no plasticizer.

As it appears from the above, the invention provides a considerable improvement to the existing technique, by supplying a fire-stop device with a simple structure ensuring very effective protection of a structure, not only by limiting the heat conduction through the device, but also and, above all, by reflecting the light and heat, this reflection possibly amounting to about 80% of the heat flux developed by a heat source such as a fire.

It goes without saying that the invention is not limited to the exemplary composition of the fire-stop device described above but, on the contrary, includes all variants. Thus, in particular, the surface covering could be applied to another insulating coating, without thereby extending beyond the scope of the invention.